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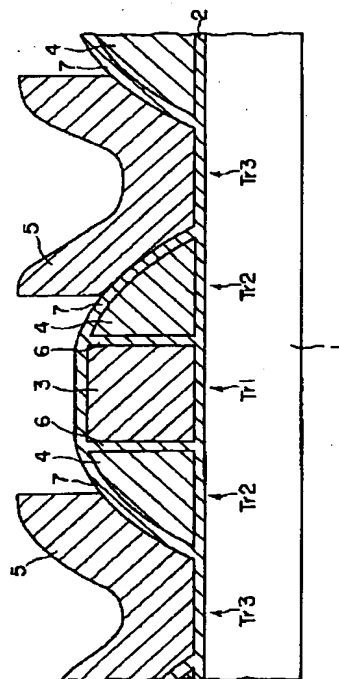
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(54) 【発明の名称】 半導体不揮発性記憶装置およびその製造方法

(57) 【要約】

【目的】 現行の加工技術の範囲内で、高集積化を図れ、ひいては低価格化を図れる半導体不揮発性記憶装置およびその製造方法を提供することにある。

【構成】 記憶素子としてはMONOSを使用し、1層目のゲートをレジスタッシング法で細らせ、ONO膜を形成した後、2層目の第2ポリシリコン層4でサイドウォールによるトランジスタを作製し、さらにONO膜を形成し、3層目の第3ポリシリコン層5でサイドウォール間にトランジスタを形成する。これにより、現行の加工技術の範囲内で、半導体不揮発性記憶装置の集積度の向上を図れる。



【特許請求の範囲】

【請求項1】 ゲート絶縁膜に電荷を蓄積する半導体不揮発性記憶装置であって、

所定間隔をおいて形成された少なくとも2つの第1の記憶素子と、

第1の記憶素子のゲート部の少なくとも一側面側に層間膜を介して形成されたサイドウォールをゲートとする第2の記憶素子と、

所定間隔をおいた2つの第2の記憶素子間に形成された第3の記憶素子とを有する半導体不揮発性記憶装置。

【請求項2】 上記ゲート絶縁膜および素子間を分離するための層間膜のうち少なくとも一方が、少なくとも窒化絶縁膜を含む絶縁膜から構成されている請求項1記載の半導体不揮発性記憶装置。

【請求項3】 記憶素子がNAND型に配列されている請求項1または請求項2記載の半導体不揮発性記憶装置。

【請求項4】 記憶素子がコンタクトレス型のNOR型に配列されている請求項1または請求項2記載の半導体不揮発性記憶装置。

【請求項5】 ゲート絶縁膜に電荷を蓄積する半導体不揮発性記憶装置の製造方法であって、

半導体基板上に絶縁膜を形成した後、

絶縁膜上に第1ポリシリコンを堆積し、

堆積させた第1ポリシリコン層をレジストアッシングにより加工して所定間隔をおいた少なくとも2つの第1の記憶素子を形成し、

基板および第1の記憶素子表面に絶縁膜を形成した後、第1の記憶素子の少なくとも一側に第2ポリシリコン層を形成し、

少なくとも第2ポリシリコン層の表面に絶縁膜を形成した後、

少なくとも所定間隔をおいた2つの第2ポリシリコン層間に第3ポリシリコン層を形成することを特徴とする半導体不揮発性記憶装置の製造方法。

【請求項6】 第3ポリシリコン層を基板、並びに第1および第2のポリシリコン層上に形成し、第3ポリシリコン層形成後にできた溝に、マスク材を自己整合的に埋め込み、これをマスクとして第3ポリシリコン層を加工する請求項5記載の半導体不揮発性記憶装置の製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、電氣的に書き換え可能な不揮発性メモリ、たとえばフラッシュEEPROMなどの半導体不揮発性記憶装置およびその製造方法に関するものである。

【0002】

【従来の技術】 不揮発性メモリは電源を切っても情報が保存されるため使いやすく、市場を拡大しつつある。こ

のような不揮発性メモリセルの配置には、大きく分けてNOR型とNAND型がある。

【0003】 図6は、NOR型不揮発性メモリセルの構成例を示す図である。図6において、 BL_1 、 BL_2 はビット線、 WL_1 、 WL_2 はワード線、 MT_{11} 、 MT_{12} 、 MT_{21} 、 MT_{22} はメモリセルトランジスタをそれぞれ示している。図6に示すように、隣合う2つのトランジスタ MT_{11} および MT_{12} 、 MT_{21} および MT_{22} で、ビットコンタクト CNT_{BL} を1個共有する。すなわち、1トランジスタ（1ビット）当りのビットコンタクト CNT_{BL} を0.5個必要とする。

【0004】 このような構成のNOR型不揮発性メモリは、他のトランジスタを介さずに直接アクセスできることから高速動作に適しているが、1ビット当りのコンタクトが0.5個必要なため集積度を上げるのが難しい。

【0005】 これに対して、NAND型不揮発性メモリは、図7に示すように、ビットコンタクト CNT_{BL} と接地との間に複数のメモリセルトランジスタ $MT_1 \sim MT_8$ が直列に接続されている。実際は、メモリセルトランジスタとビットコンタクト CNT_{BL} およびグランド間に選択トランジスタが挿入されるが、ビットコンタクト CNT_{BL} は隣接する直列メモリセルトランジスタ群とも共有する。したがって、8ビット直列セルの場合、計 $(8+2) \times 2 = 20$ トランジスタに1個で済む。

【0006】 このような構成のNAND型不揮発性メモリは、直列に接続されたメモリセルに対し、コンタクトは1個で済むので高集積化には適しているものの、アクセスしたいトランジスタに直列に他のトランジスタが接続されていることから、高速動作が必要な用途には使用できない。

【0007】 そこで、高速性はそれほど要求しないが大容量が必要な場合、たとえばハードディスクの置き換えや固定テープにはNAND型不揮発性メモリが有望とされている。この種の用途に用いられる場合は、価格が低いことが一般に広く用いられるために極めて重要である。NAND型不揮発性メモリは、単価面積当りのビット数がNOR型不揮発性メモリより大きいので、コスト的に有利であり、その意味でもこの種の用途に向いている。

【0008】

【発明が解決しようとする課題】 しかしながら、通常のNAND構造のままですらに集積度を向上させるには、微細化を進める必要があるが、それは現行の加工技術を用いるだけでは限度がある。また、そのための新しい微細加工技術を開発するために、時間的・技術的・コスト的に困難を伴う。

【0009】 本発明は、かかる事情に鑑みてなされたものであり、その目的は、現行の加工技術の範囲内で、高集積化を図れ、ひいては低価格化を図れる半導体不揮発性記憶装置およびその製造方法を提供することにある。

【0010】

【課題を解決するための手段】上記目的を達成するため、本発明のゲート絶縁膜に電荷を蓄積する半導体不揮発性記憶装置は、所定間隔をおいて形成された少なくとも2つの第1の記憶素子と、第1の記憶素子のゲート部の少なくとも一側面側に層間膜を介して形成されたサイドウォールをゲートとする第2の記憶素子と、所定間隔をおいた2つの第2の記憶素子間に形成された第3の記憶素子とを有する。

【0011】また、本発明の半導体不揮発性記憶装置は、上記ゲート絶縁膜および素子間を分離するための層間膜のうち少なくとも一方が、少なくとも窒化絶縁膜を含む絶縁膜から構成されている。

【0012】また、本発明の半導体不揮発性記憶装置では、記憶素子がNAND型、あるいはコンタクトレス型のNOR型に配列される。

【0013】また、本発明のゲート絶縁膜に電荷を蓄積する半導体不揮発性記憶装置の製造方法では、半導体基板上に絶縁膜を形成した後、絶縁膜上に第1ポリシリコンを堆積し、堆積させた第1ポリシリコン層をレジストアッシングにより加工して所定間隔をおいた少なくとも2つの第1の記憶素子を形成し、基板および第1の記憶素子表面に絶縁膜を形成した後、第1の記憶素子の少なくとも一側に第2ポリシリコン層を形成し、少なくとも第2ポリシリコン層の表面に絶縁膜を形成した後、少なくとも所定間隔をおいた2つの第2ポリシリコン層間に第3ポリシリコン層を形成する。

【0014】また、本発明の半導体不揮発性記憶装置の製造方法では、第3ポリシリコン層を基板、並びに第1および第2のポリシリコン層上に形成し、第3ポリシリコン層形成後にできた溝に、マスク材を自己整合的に埋め込み、これをマスクとして第3ポリシリコン層を加工する。

【0015】

【作用】本発明の半導体不揮発性記憶装置によれば、現行の加工技術の範囲内で、半導体不揮発性記憶装置の集積度が4倍に向上する。

【0016】また、本発明の製造方法によれば、まず、半導体基板上に絶縁膜が形成された後、絶縁膜上に第1ポリシリコンが堆積される。堆積された第1ポリシリコン層は、レジストアッシング法を用いてその幅が加工される。これにより、所定間隔をおいた少なくとも2つの第1の記憶素子が形成される。次に、基板および第1の記憶素子表面に絶縁膜が形成された後、第1の記憶素子の少なくとも一側に第2ポリシリコン層が形成され、第2の記憶素子が構成される。次いで、少なくとも第2ポリシリコン層の表面に絶縁膜が形成された後、少なくとも所定間隔をおいた2つの第2ポリシリコン層間に第3ポリシリコン層が形成され、第3の記憶素子が構成される。

【0017】また、本発明によれば、第3ポリシリコン層が基板、並びに第1および第2のポリシリコン層上に形成される。このとき、第2ポリシリコン層間に形成される第3ポリシリコン層には溝ができる。この第3ポリシリコン層形成後にできた溝に、マスク材が自己整合的に埋め込まれ、これをマスクとして第3ポリシリコン層が2つの第2ポリシリコン層間に位置するように加工される。

【0018】

10 【実施例】図1は、本発明に係るNAND型半導体不揮発性記憶装置の一実施例を示す断面図である。図1において、Tr1は第1のトランジスタ、Tr2は第2のトランジスタ、Tr3は第3のトランジスタ、1は半導体基板、2はゲート絶縁膜、3は第1ポリシリコン層、4は第2ポリシリコン層、5は第3ポリシリコン層、6、7は層間絶縁膜をそれぞれ示している。

20 【0019】第1のトランジスタTr1は、ゲートが第1ポリシリコン層3により構成された、いわゆるMONOS型トランジスタである。すなわち、MOSTランジスタのゲート絶縁膜が、図2に示すように、 $\text{SiO}_2/\text{SiN}/\text{SiO}_2$ の3層からなるONO絶縁膜により構成されたメモリトランジスタである。

【0020】第2のトランジスタTr2は、ゲートが第2ポリシリコン層4により構成されたMONOS型トランジスタである。ゲートを構成する第2ポリシリコン層4は、第1ポリシリコン層3の両側に層間絶縁膜6を介し、いわゆるサイドウォールとして形成されている。

30 【0021】第2のトランジスタTr3は、ゲートが第3ポリシリコン層5により構成されたMONOS型トランジスタである。第3ポリシリコン層5は、隣接する第2のトランジスタTr2間のゲート絶縁膜2上、並びに第1ポリシリコン層3および第2ポリシリコン4上に形成された層間絶縁膜7上に形成されている。

【0022】このように、本実施例においては、図2に示すような構造を有するONO膜が、第1～第3のトランジスタTr1、Tr2、Tr3のゲート絶縁膜として用いられ、メモリ機能を保持するのに利用されると共に、各トランジスタ間の層間絶縁膜としての機能も持つ。この場合、ONOの最下層の酸化膜(Bottom Oxとも呼ぶ)はポリシリコンを酸化することにより得られるが、ポリシリコン上の酸化膜は単結晶シリコンからなる基板1上より厚くなる性質があるので、層間絶縁の目的に好適である。

【0023】次に、図3を参照しながら、図1の半導体不揮発性記憶装置の製造方法について説明する。なお、形状に直接関係のないイオン注入等の工程の説明は省略している。

50 【0024】まず、図3(a)に示すように、基板1上にゲート絶縁膜2となるONO膜を形成した後、CVD法によりポリシリコンPolyを250nm程度の膜厚

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で堆積した後、燐をドーピングする。なお、ゲート絶縁膜2の膜厚は、たとえば、ONO膜の最下層の SiO_2 の膜厚は2nm、中間の SiN の膜厚は4nm、最上層の SiO_2 の膜厚は3nmに設定する。

【0025】次に、図3(b)に示すように、リソグラフィの手法により最小のデザインルールのライン/スペース(L/S)をレジストPRでパターンニングする。パターン間隔は、たとえば0.4 μm 程度に設定する。

【0026】次に、図3(c)に示すように、レジストアッシング法を用い、酸素プラズマ中でレジストPRを等方的にエッチングし、レジスト線幅を0.2 μm 程度に細らせる。この際、細らせる量は第1～第3のトランジスタTr1、Tr2、Tr3のゲート長が最終的に同じになるように考慮して決定する。これにより、隣接するレジストパターン間の距離は、0.6 μm 程度となる。レジストアッシング法の具体的な条件としては、パワー100W、圧力200mTorr、酸素ガス20SCCMに設定する。

【0027】次いで、図3(d)に示すように、RIEによりポリシリコンおよびONO膜を除去した後、レジストを剥離する。次に、図3(e)に示すように、基板1およびパターン上にONO膜を形成する。このとき、基板1上のONO膜は第1のトランジスタTr1のONO膜と同じ膜厚になるように形成するが、前述したように、第1のトランジスタTr1の側面と上面のONO膜は基板1上より厚くなる。これは、上述したように、ボトム(Bottom)Oxがポリシリコン上で厚くなるためである。

【0028】次に、図4(f)に示すように、CVD法により第2ポリシリコン層4を形成し、燐をドーピングした後、RIEでエッチバックし第2ポリシリコン層4のサイドウォールを形成する。この場合、第1ポリシリコン層3および第2ポリシリコン層4が形成されていない領域で、後で第3のトランジスタTr3が形成される基板1上の領域のONO膜を除去する。そのため、第1のトランジスタTr1の上面のONO膜もほとんど除去される。

【0029】次に、図4(g)に示すように、基板1、第1ポリシリコン層3および第2ポリシリコン層4上にONO膜を形成する。このとき、基板1上のONO膜は、第1のトランジスタTr1および第2のトランジスタTr2のONO膜と同じ膜厚となるように形成するが、上述したように、第1のトランジスタTr1の上面と第2のトランジスタTr2の上面のONO膜は、基板1上より厚くなる。

【0030】次に、図4(h)に示すように、全体のONO膜上にCVD法により第3ポリシリコン層3Poly(5)を形成した後、燐をドーピングする。次に、図4(i)に示すように、リソグラフィによりパターンニングする。このときのスペースはデザインルールの最小

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間隔で良く、合わせずれマージンを取らなくてよい。合わせずれマージンはサイドウォールで代用できるからである。そして、図4(j)に示すように、RIEで第1のトランジスタTr1および第1のトランジスタTr1近傍領域に位置する第2にトランジスタTr2上のポリシリコン層を除去し、レジスト膜を剥離する。以下、層間絶縁膜の形成等の工程に進む。

【0031】また、上述した図4(i)および(j)の工程の代わりに、たとえば図4(h)で第3ポリシリコン層5を形成したときにできた溝に、マスク材、たとえば SiO_2 、SOGあるいはレジストを自己整合的に埋め込み、それをマスクとして第3ポリシリコン層5を加工するようにしてもよい。

【0032】次に、図5を用いて結果的に1単位のライン/スペースの中に幾つのメモリトランジスタを形成可能であるかを考察する。なお、図4において、Lは最小デザインルールを示しており、簡単のためライン/スペースを4L/4Lの長さとしている。また、ONOの膜厚は無視している。

【0033】図5(a)に示すように、通常の第1ポリシリコンの場合は、ライン/スペース1単位でメモリトランジスタは1個だけである。これに対して、本実施例では、図5(b)に示すように、4L+4L=8Lの中に、ゲート長2Lのトランジスタが4つ形成される。具体的には、第1のトランジスタTr1が1個、第2トランジスタTr2が2個、第3のトランジスタTr3が1個の計4個となる。その結果、本実施例によれば、集積度を通常の4倍にすることができる。

【0034】以上説明したように、本実施例によれば、素子としてはMONOSを使用し、1層目のゲートをレジストアッシング法で細らせ、ONO膜を形成した後、2層目の第2ポリシリコン4でサイドウォールによるトランジスタを作製し、さらにONO膜を形成し、3層目の第3ポリシリコン層5でサイドウォール間にトランジスタを形成したので、現行の加工技術の範囲内で、不揮発性メモリの集積度を向上することができる。その結果、ビット当りのコストを低減することができることから、製品の価格を下げられる等の利点がある。また、サイドウォールにより合わせずれマージンを吸収し、最小加工寸法を用いてメモリセルを形成することができる。

【0035】なお、本実施例では、NAND型半導体不揮発性記憶装置を例に説明したが、これに限定されるものではなく、たとえばコンタクトレス型のNOR半導体不揮発性記憶装置にも本発明が適用できることはいうまでもない。

【0036】

【発明の効果】以上説明したように、本発明によれば、現行の加工技術の範囲内で、不揮発性メモリの集積度を向上することができる。その結果、ビット当りのコストを低減することができることから、製品の価格を下げら

れる等の利点がある。

【図面の簡単な説明】

【図1】本発明に係るNAND型半導体不揮発性記憶装置の一実施例を示す断面図である。

【図2】ONO構造の説明図である。

【図3】図1の半導体不揮発性記憶装置の製造方法を説明するための図である。

【図4】図1の半導体不揮発性記憶装置の製造方法を説明するための図である。

【図5】本発明品と従来品との集積度を比較、説明するための図である。

【図6】NOR型メモリセルを説明するための図である。

【図7】NAND型メモリセルを説明するための図である。

【符号の説明】

Tr1…第1のトランジスタ

Tr2…第2のトランジスタ

Tr3…第3のトランジスタ

1…半導体基板

2…ゲート絶縁膜

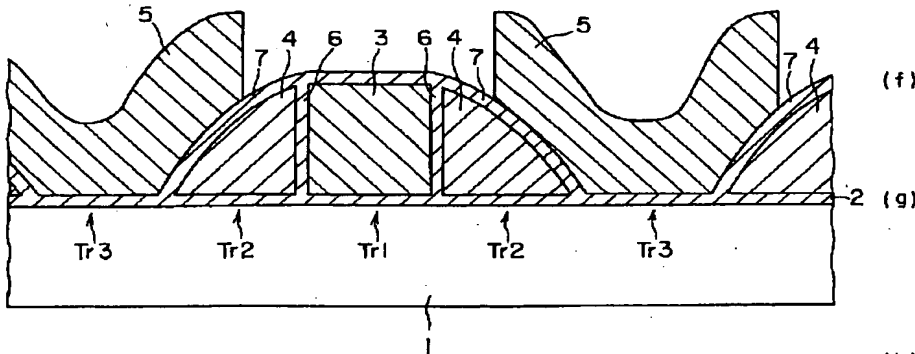
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4…第2ポリシリコン層

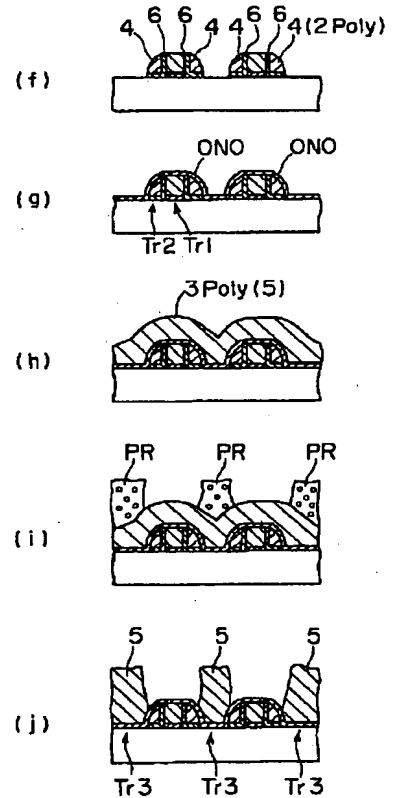
5…第3ポリシリコン層

6, 7…層間絶縁膜

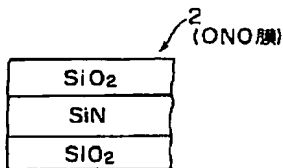
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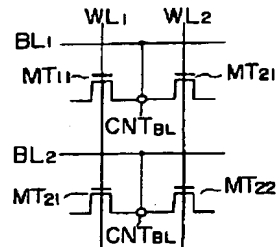
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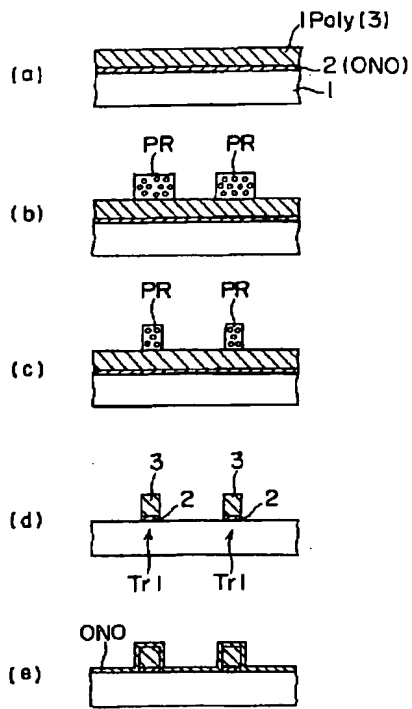
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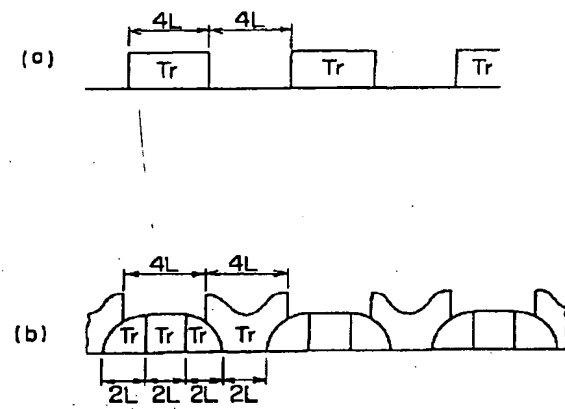
【図6】



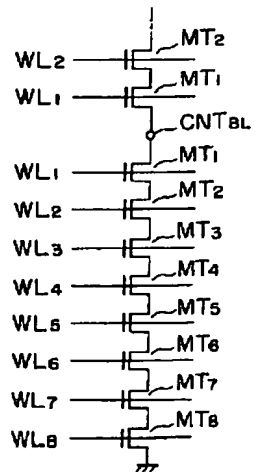
【図 3】



【図 5】



【図 7】



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(54) SEMICONDUCTOR NONVOLATILE MEMORY AND ITS MANUFACTURE

(57) Abstract: PURPOSE: To provide a semiconductor nonvolatile memory, which can be manufactured in high integration in terms of the existing processing technology and at low cost, and its manufacturing method. CONSTITUTION: MONOS is used as a memory element. A first layer gate is thinned down by the resist ashing method. After an ONO film is formed, a transistor is made by a sidewall at a second layer which is a second polysilicon layer 4; then, the ONO film is formed to form a transistor between sidewalls in a third layer which is a third polysilicon layer 5. This enables the integration of a semiconductor nonvolatile memory to be improved.

[Claim(s)]

[Claim 1] The semiconductor nonvolatile storage which accumulates a charge to a gate insulator layer, which has at least

two 1st storage elements formed setting a predetermined spacing

the 2nd storage element which makes the side wall the gate formed on at least the 1 side-face side of the gate section of the 1st storage element through the layer inbetween, and

the 3rd storage element formed between the 2nd two storage elements which set the predetermined spacing.

[Claim 2] The semiconductor nonvolatile storage according to claim 1 in which at least

one side is constituted from an insulator layer which contains a nitriding insulator layer at least among the layer inbetween for separating between the above-mentioned gate insulator layer and an element.

[Claim 3] The semiconductor nonvolatile storage according to claim 1 or 2 in which the storage element is arranged as NAND type.

[Claim 4] The semiconductor nonvolatile storage according to claim 1 or 2 in which the storage element is arranged as contact less type NOR type.

[Claim 5] A manufacture technique of the semiconductor nonvolatile storage which accumulates a charge to a gate insulator layer, and is characterized by the following:

After forming an insulator layer on a semiconductor substrate, the 1st polysilicon is deposited on said insulator layer, the deposited 1st polysilicon layer is processed by resist-ashing, and the predetermined spacing is set and at least two first storage elements are formed,

after forming an insulator layer on the substrate and the 1st storage element front face, a 2nd polysilicon layer is formed on at least one of the sides of the 1st storage element, and

after forming an insulator layer on the front face of the 2nd polysilicon layer at least, between the at least two 2nd polysilicon layers which are set at a predetermined spacing the 3rd polysilicon layer is formed.

[Claim 6] The manufacture technique of the semiconductor nonvolatile storage according to claim 5, in which

the 3rd polysilicon layer is formed on the substrate, the 1st, and the 2nd polysilicon layers,

in the groove created by the 3rd polysilicon layer forming, mask material is self-adjustingly applied, and with this as a mask the 3rd polysilicon layer is formed.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a semiconductor nonvolatile storage and its manufacture technique, such as an electrically rewritable non-volatile memory, for example, a flash EEPROM etc.

[0002]

[Description of the Prior Art] Since the information is saved even if the power is turned off, non-volatile memories are easy to use, and their market keeps expanding. They roughly divide into nonvolatile memory cell layouts of the NOR type and of the NAND type.

[0003] Fig. 6 is a drawing showing an example of a configuration of a NOR type nonvolatile memory cell. In Fig. 6, BL1, BL2 show bit lines, WL1, and WL2 show word lines, and MT11, MT12, MT21 and MT22 show memory cell transistors, respectively. As shown in Fig. 6, one bit contact CNTBL is shared between two adjacent transistors MT11 and MT12, MT21 and MT22. That is, 0.5 bit contact CNTBLs per one transistor (1 bit) are needed.

[0004] Although it is suitable for fast operation since such NOR type non-volatile memory of a configuration can be directly accessed without the mediation of other transistors, it is difficult to raise the degree of integration since every bit needs 0.5 contacts.

[0005] On the other hand, in the case of NAND type non-volatile memories, a plurality of memory cell transistors MT1 - MT8 are connected in series between the bit contacts CNTBL and the electrical grounding, as shown in Fig. 7.

In practice, although between a memory cell transistor and bit contact CNTBL and the ground, a selection transistor is inserted, the bit contact CNTBL shares an adjoining in-series memory cell transistor group.

Therefore, in the case of 8 bit-serial cells, one piece requires only a total of $(8+2) \times 2 = 20$ transistors.

[0006] A NAND type non-volatile memory of such a configuration, compared to the memory cell which was connected in series, although since a contact can be managed with one piece it is suitable for high integration, since other transistors are connected to the transistor to be accessed in series, it cannot be used for required intended fast turn around use.

[0007] Then, NAND type non-volatile memory is promising when although rapidity is not demanded so much, but large capacity is required, for example for the displacement of a hard disk and fixed tape.

When used for this kind of intended use, since it is generally used widely, that price is low, it is very important.

Since the number of bits per unit price area is larger than NOR type non-volatile memory,

NAND type non-volatile memory is advantageous in cost, and in this respect too is advantageous for this kind of intended use.

[0008]

[Problem(s) to be Solved by the Invention] However, although it is necessary to advance micronization in order to raise a degree of integration further with usual NAND structure, it is limited if using only present processing technique.

Moreover, in order to develop the new micro-processing technique for it, it is accompanied by the distress in time, technical, and cost.

[0009] The purpose of this invention is to offer the semiconductor nonvolatile storage and its manufacture technique in view of such a situation, and to attain high integration within the limits of present processing techniques, and as a result to attain cost reduction.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the semiconductor nonvolatile storage of this invention which accumulates a charge to the gate insulator layer has

- at least two 1st storage element which was formed sets a predetermined spacing,
- the 2nd storage element which uses as the gate the side wall formed on at least 1 side-face side of the gate section of the 1st storage element through the layer inbetween, and
- the 3rd storage element formed between the two 2nd storage elements which set the predetermined spacing.

[0011] Moreover, the semiconductor nonvolatile storage of this invention consists of an insulator layer in which at least one side contains a nitriding insulator layer at least among the layer inbetween for separating between the above-mentioned gate insulator layer and an element.

[0012] Moreover, a storage element is arranged by NAND type or contact less type NOR type in the semiconductor nonvolatile storage of this invention.

[0013] Moreover, the manufacture technique of the semiconductor nonvolatile storage which accumulates a charge to the gate insulator layer of this invention includes the steps of

- after forming an insulator layer on a semiconductor substrate, the 1st polysilicon is deposited on an insulator layer,
- the 1st polysilicon layer made to deposit is processed by resist-ashing, and the at least two 1st storage elements are formed setting the predetermined spacing,
- after forming an insulator layer on a substrate and the 1st storage element front face, the 2nd polysilicon layer is formed on at least 1 side of the 1st storage element,

after forming an insulator layer on the front face of the 2nd polysilicon layer at least, the 3rd polysilicon layer is formed between the at least two 2nd polysilicon layers which set the predetermined spacing.

[0014] Moreover, by the manufacture technique of the semiconductor nonvolatile storage of this invention, the 3rd polysilicon layer is formed on the substrate, the 1st, and 2nd polysilicon layers, and the 3rd polysilicon layer is processed into the slot made after the 3rd polysilicon stratification, embedding mask material on a self-matching target and using this as a mask.

[0015]

[Function] According to the semiconductor nonvolatile storage of this invention, the degree of integration of a semiconductor nonvolatile storage improves by 4 times within the limits of present manipulation technique.

[0016] Moreover, according to the manufacture technique of this invention,

first, after forming an insulator layer on a semiconductor substrate, the 1st polysilicon is accumulated on an insulator layer.

As for the deposited 1st polysilicon layer, the width of face is processed using the resist-ashing method.

Thereby the at least two 1st storage elements are formed at set predetermined spacing.

Next, after forming an insulator layer on a substrate and the 1st storage element front face, the 2nd polysilicon layer is formed in the at least 1 side of the 1st storage element, and the 2nd storage element is constituted.

Subsequently, after forming an insulator layer in the front face of the 2nd polysilicon layer at least, the 3rd polysilicon layer is formed between the at least two 2nd polysilicon layers which set the predetermined spacing, and the 3rd storage element is constituted.

[0017] Moreover, according to this invention, the 3rd polysilicon layer is formed on the substrate, the 1st, and 2nd polysilicon layers.

At this time, a slot is made in the 3rd polysilicon layer formed between the 2nd polysilicon layers.

In the slot made after this 3rd polysilicon stratification, mask material is embedded on a self-matching target and using this as a mask, the 3rd polysilicon layer is processed so that it may be located between the two 2nd polysilicon layers.

[0018]

[Embodiment] Fig. 1 is a cross section showing one embodiment of NAND type semiconductor nonvolatile storage concerning this invention.

In Fig. 1, Tr1 is the 1st transistor, Tr2 the 2nd transistor, Tr3 the 3rd transistor, 1 the

semiconductor substrate and 2 the gate insulator layer, 3 the 1st polysilicon layer, 4 the 2nd polysilicon layer, 5 the 3rd polysilicon layer and 6 and 7 show the inbetween layers insulation layer, respectively.

[0019] The 1st transistor Tr1 is the so-called MONOS type transistor from which the gate was constituted by the 1st polysilicon layer 3. That is, the gate insulator layer of an MOS transistor, as shown in Fig. 2, is the memory transistor constituted by ONO insulator layers which consist of three SiO₂/SiN/SiO₂ layers.

[0020] The 2nd transistor Tr2 is a MONOS type transistor from which the gate was constituted by the 2nd polysilicon layer 4.

The 2nd polysilicon layer 4 which constitutes the gate is formed in the both sides of the 1st polysilicon layer 3, through the inbetween-layers insulation layer 6, as the side wall, that is:

[0021] The 2nd transistor Tr3 is MONOS type transistor from which the gate was constituted by the 3rd polysilicon layer 5.

The 3rd polysilicon layer 5 is formed on the layer insulation layer 7 formed on the 1st polysilicon layer 3 and the 2nd polysilicon 4 and on the gate insulator layer 2 between the adjoining 2nd transistors Tr2.

[0022] Thus, in this embodiment, the ONO layer which has the structure as shown in Fig. 2 is used as a gate insulator layer of the 1st to the 3rd transistor Tr1, Tr2, and Tr3, and while it is used for holding a memory function, it also has a function as a layer insulation layer between each transistor.

In this case, although the oxide film (referred to also as Bottom Ox) of the lowest layer of ONO is obtained by oxidizing polysilicon, since the oxide film on a polysilicon has the property of becoming thicker than the substrate 1 top which consists of single crystal silicon, it is suitable for the purpose of layer insulation.

[0023] Next, the manufacture technique of the semiconductor nonvolatile storage of Fig. 1 is explained, referring to Fig. 3.

In addition, the explanation of processes, such as an ion implantation without the direct relation to a configuration, is omitted.

[0024] First, phosphorus is doped, after forming ONO layer used as the gate insulator layer 2 on a substrate 1 and depositing polysilicon Poly by the about 250nm thickness by CVD, as shown in Fig. 3 (a).

In addition, the thickness of the gate insulator layer 2 is, for example, set by the thickness of the lowest SiO₂ ONO layer of 2nm,

the thickness of the middle SiN layer of 4nm and
the thickness of the uppermost SiO₂ layer of 3nm.

[0025] Next, as shown in Fig. 3 (b), patterning of the line / space of the minimum design rule (L/S) is carried out by resist PR by the technique of lithography.

A pattern spacing is set as about 0.4 micrometers.

[0026] Next, as shown in Fig. 3 (c), using the resist-ashing method, resist PR are etched isotropic in an oxygen plasma, and resist line breadth is dwindled to about 0.2 micrometers.

In this case, the amount to dwindle is determined taking into consideration that the gate length of the 1st to the 3rd transistor Tr1, Tr2, and Tr3 will finally become the same.

Thereby, the distance between adjoining resist patterns is set to about 0.6 micrometers.

As concrete conditions of the resist-ashing method, the power is set at 100W, pressure at 200mTorr, and oxygen gas at 20SCCM.

[0027] Subsequently, a resist is exfoliated, after removing polysilicon and ONO layer by RIE, as shown in Fig. 3 (d).

Next, as shown in Fig. 3 (e), ONO layer is formed on the substrate 1 and a pattern.

Although ONO layer on a substrate 1 is formed at this time so that it may become the same thickness as ONO layer of the 1st transistor Tr1,

as mentioned above, ONO layer of the side and top face of the 1st transistor Tr1 becomes thicker than on top of the substrate 1.

This is because a bottom Ox becomes thick on a polysilicon, as mentioned above.

[0028] Next, as shown in Fig. 4 (f), after forming the 2nd polysilicon layer 4 by CVD and doping phosphorus, etchback is carried out by RIE and the side wall of the 2nd polysilicon layer 4 is formed.

In this case, in the field in which the 1st polysilicon layer 3 and the 2nd polysilicon layer 4 is not formed, the field of the ONO layer of substrate 1 in which 3rd transistor Tr3 is formed is later removed.

Therefore, most of the ONO layers of the top of the 1st transistor Tr1 are removed.

[0029] Next, as shown in Fig. 4 (g), the ONO layer is formed on top of substrate 1, on top of the 1st polysilicon layer 3 and the 2nd polysilicon layer 4.

Although the ONO layer on top of substrate 1 is formed so as to have the same layer thickness as the ONO layer of the 1st polysilicon layer 3 and the 2nd polysilicon layer 4, as mentioned above, the ONO layer on top of the 1st transistor Tr1 and on top of the 2nd transistor Tr2 becomes thicker than on top of substrate 1.

[0030] Next, phosphorus is doped, after forming 3rd polysilicon layer 3 Poly (5) by CVD on the whole ONO layer, as shown in Fig. 4 (h).

Next, as shown in Fig. 4 (i), patterning is carried out with lithography.

The space at this time is good at the minimum spacing of a design rule, and does not need to take a doubling gap margin.

That is because the doubling gap margin can be substituted by a side wall.

And as shown in Fig. 4 (j), the polysilicon layer on the 2nd transistor Tr2 located about in the 1st transistor Tr1 field and on the 1st transistor Tr 1 is removed by RIE, and a resist layer is exfoliated.

Hereafter, the explanation progresses to processes, such as formation of a inbetween layers insulation layer.

[0031] Moreover, instead of the process of the Fig. 4 (i) and (j) mentioned above, for example as in Fig. 4 (h), you may be made to process the 3rd polysilicon layer 5, embedding for example, SiO, SOG, or a resist on a self-matching target as the mask material 2 into the slot made when the 3rd polysilicon layer 5 was formed, and using it as a mask.

[0032] Next, it considers how many memory transistors can be formed into the line/space of one unit as a result using Fig. 5 .

In addition, in Fig. 4 , L shows the minimum design rule, and since it is easy, it makes a line/space the length of $4L/4L$.

Moreover, the thickness of ONO is ignored.

[0033] As shown in Fig. 5 (a), in the usual 1st polysilicon case, the number of memory transistors is one in a line / space 1 unit.

On the other hand, in this embodiment, as shown in Fig. 5 (b), four transistors of gate-length $2L$ are formed into $4L+4L=8L$.

Specifically, one 1st transistor Tr1, two 2nd transistor Tr2, and one 3rd transistor Tr3 becomes a total of four pieces.

Consequently, according to this embodiment, the degree of integration can be increased to 4 times the usual.

[0034] As explained above, according to this example, after dwindling the gate of the 1st layer by the resist-ashing method and forming ONO layer, using MONOS as an element, since the transistor by the side wall is produced with the 2nd layer of 2nd polysilicon 4, ONO layer is formed further and the transistor is formed between the side walls in the 3rd layer of 3rd polysilicon layer 5, within the limits of present manipulation technique, the degree of integration of non-volatile memory can be improved.

Consequently, since the cost per bit can be reduced, there is an advantage which can lower

the price of a product.

Moreover, the side wall doubling gap margins can be absorbed, and a memory cell can be formed using the minimum manipulation dimension.

[0035] In addition, at this embodiment, although NAND type semiconductor nonvolatile storage was explained as an example, it cannot be overemphasized that it is not limited to this and this invention can be applied also to contact less type NOR semiconductor nonvolatile storage.

[0036]

[Effect of the Invention] As explained above, according to this invention, the degree of integration of non-volatile memory can be improved within the limits of present manipulation technique. Consequently, since the cost per bit can be reduced, there is an advantage which can lower the price of a product.

[Brief Description of the Drawings]

[Fig. 1] It is the cross section showing one example of NAND type semiconductor nonvolatile storage concerning this invention.

[Fig. 2] It is explanatory Fig. of ONO structure.

[Fig. 3] It is drawing for explaining the manufacture technique of the semiconductor nonvolatile storage of Fig. 1 .

[Fig. 4] It is drawing for explaining the manufacture technique of the semiconductor nonvolatile storage of Fig. 1 .

[Fig. 5] It is drawing for measuring and explaining the degree of integration with elegance this invention article and conventionally.

[Fig. 6] It is drawing for explaining NOR type memory cell.

[Fig. 7] It is drawing for explaining NAND type memory cell.

[Description of Notations]

Tr1 -- The 1st transistor

Tr2 -- The 2nd transistor

Tr3 -- The 3rd transistor

1 -- Semiconductor substrate

2 -- Gate insulator layer

3 -- The 1st polysilicon layer

4 -- The 2nd polysilicon layer

5 -- The 3rd polysilicon layer

6, 7 -- Between layer insulation layer

PATENT ABSTRACTS OF JAPAN

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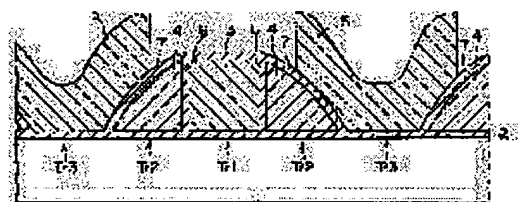
(72)Inventor : KUBOTA MICHITAKA

(54) SEMICONDUCTOR NONVOLATILE MEMORY AND ITS MANUFACTURE

(57)Abstract:

PURPOSE: To provide a semiconductor nonvolatile memory, which can be manufactured in high integration in terms of the existing processing technology and at low cost, and its manufacturing method.

CONSTITUTION: MONOS is used as a memory element. A first layer gate is thinned down by the resist ashing method. After an ONO film is formed, a transistor is made by a sidewall at a second layer which is a second polysilicon layer 4; then, the ONO film is formed to form a transistor between sidewalls in a third layer which is a third polysilicon layer 5. This enables the integration of a semiconductor nonvolatile memory to be improved.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] A semiconductor nonvolatile storage which is a semiconductor nonvolatile storage which accumulates a charge in a gate insulator layer, and has 1st at least two storage element which set a predetermined gap and was formed, the 2nd storage element which makes the gate a sidewall of the gate section of the 1st storage element formed in a 1 side side through an interlayer film at least, and the 3rd storage element formed between the 2nd two storage element which set a predetermined gap.

[Claim 2] A semiconductor nonvolatile storage according to claim 1 which consists of insulator layers in which at least one side contains a nitriding insulator layer at least among interlayer films for separating between the above-mentioned gate insulator layer and an element.

[Claim 3] A semiconductor nonvolatile storage according to claim 1 or 2 with which a storage element is arranged by NAND mold.

[Claim 4] A semiconductor nonvolatile storage according to claim 1 or 2 with which a storage element is arranged by NOR mold of a contact loess mold.

[Claim 5] It is the manufacture method of a semiconductor nonvolatile storage which accumulates a charge in a gate insulator layer. After forming an insulator layer on a semiconductor substrate, the 1st polish recon is deposited on an insulator layer. If few, two storage elements which processed the 1st polish recon layer made to deposit by resist-ashing, and set a predetermined gap and which are the 1st will be formed. After forming an insulator layer in a substrate and the 1st storage element front face, the 2nd polish recon layer is formed in the at least 1 side of the 1st storage element. A manufacture method of a semiconductor nonvolatile storage characterized by forming the 3rd polish recon layer between the two 2nd polish recon layers which set a predetermined gap at least after forming an insulator layer in a front face of the 2nd polish recon layer at least.

[Claim 6] A manufacture method of a semiconductor nonvolatile storage according to claim 5 of forming the 3rd polish recon layer on the 1st and 2nd polish recon layers at a substrate and a list, embedding mask material in self align in a slot made after the 3rd polish recon stratification, and processing the 3rd polish recon layer by making this into a mask.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to a semiconductor nonvolatile storage and its manufacture methods, such as rewritable nonvolatile memory, for example, a flash EEPROM etc., electrically.

[0002]

[Description of the Prior Art] Since information is saved even if it turns off the power, it is easy to use nonvolatile memory, and it is expanding a commercial scene. It roughly divides into arrangement of such a non-volatile memory cell, and there are a NOR mold and a NAND mold in it.

[0003] Drawing 6 is drawing showing the example of a configuration of a NOR mold non-volatile memory cell. It sets to drawing 6 and they are BL1 and BL2. A bit line, WL1, and WL2 A word line, and MT11, MT12, MT21 and MT22 show the memory cell transistor, respectively. As shown in drawing 6, one bit contact CNTBL is shared between the transistor MT 11 of two *****, and MT12, MT21 and MT22. That is, 0.5 bit contacts CNTBL of per one transistor (1 bit) are needed.

[0004] Since such NOR mold nonvolatile memory of a configuration can carry out direct access, without minding other transistors, it is suitable for high-speed operation, but since per bit needs 0.5 to be contacted, it is difficult for it to raise a degree of integration.

[0005] On the other hand, NAND mold nonvolatile memory is the memory cell transistor MT 1 of plurality [between / the bit contact CNTBL and touch-down] - MT8, as shown in drawing 7. It connects with the serial. In practice, although a selection transistor is inserted between a memory cell transistor, the bit contact CNTBL, and a gland, the bit contact CNTBL is shared also with an adjoining serial memory cell transistor group. Therefore, in the case of 8 bit-serial cel, it ends with one piece to 2= total (8+2) x20 transistor.

[0006] Since contact can be managed with one piece to the memory cell by which such NAND mold nonvolatile memory of a configuration was connected to the serial, although it is suitable for high integration, since other transistors are connected to the transistor to access at the serial, high-speed operation cannot use it for a required use.

[0007] Then, although rapidity is not required so much, when large capacity is required, it is made promising [NAND mold nonvolatile memory] for replacement and fixed tape of a hard disk. When used for this kind of use, since it is generally used widely that a price is low, it is very important. Since the number of bits per unit price area is larger than NOR mold nonvolatile memory, NAND mold nonvolatile memory is advantageous in cost, and has turned to this kind of use also in that semantics.

[0008]

[Problem(s) to be Solved by the Invention] However, although it is necessary to advance detailed-ization in order to raise a degree of integration further with the usual NAND structure, it is limited only by using the present processing technology. Moreover, in order to develop the new ultra-fine processing technology for it, it is accompanied by difficulty in time, technical, and cost.

[0009] It is in offering the semiconductor nonvolatile storage which this invention can be made in view of this situation, and the object can attain high integration within the limits of the present processing technology, as a result can attain low-pricing, and its manufacture method.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned object, a semiconductor nonvolatile storage which accumulates a charge in a gate insulator layer of this invention 1st at least two storage element which set a predetermined gap and was formed, and the 2nd storage element which makes the gate a sidewall of the gate section of the 1st storage element formed in a 1 side side through an interlayer film at least, It has the 3rd storage element formed

between the 2nd two storage element which set a predetermined gap.

[0011] Moreover, a semiconductor nonvolatile storage of this invention consists of insulator layers in which at least one side contains a nitriding insulator layer at least among interlayer films for separating between the above-mentioned gate insulator layer and an element.

[0012] Moreover, a storage element is arranged by NOR mold of a NAND mold or a contact loess mold in a semiconductor nonvolatile storage of this invention.

[0013] moreover, by manufacture method of a semiconductor nonvolatile storage which accumulates a charge in a gate insulator layer of this invention After forming an insulator layer on a semiconductor substrate, the 1st polish recon is deposited on an insulator layer. If few, two storage elements which processed the 1st polish recon layer made to deposit by resist-ashing, and set a predetermined gap and which are the 1st will be formed. After forming an insulator layer in a substrate and the 1st storage element front face, the 2nd polish recon layer is formed in the at least 1 side of the 1st storage element. After forming an insulator layer in a front face of the 2nd polish recon layer at least, the 3rd polish recon layer is formed between the two 2nd polish recon layers which set a predetermined gap at least.

[0014] Moreover, by manufacture method of a semiconductor nonvolatile storage of this invention, the 3rd polish recon layer is formed on the 1st and 2nd polish recon layers at a substrate and a list, mask material is embedded in self align in a slot made after the 3rd polish recon stratification, and the 3rd polish recon layer is processed on it by making this into a mask.

[0015]

[Function] According to the semiconductor nonvolatile storage of this invention, the degree of integration of a semiconductor nonvolatile storage improves by 4 times within the limits of the present processing technology.

[0016] Moreover, according to the manufacture method of this invention, first, after an insulator layer is formed on a semiconductor substrate, the 1st polish recon accumulates on an insulator layer. As for the deposited 1st polish recon layer, the width of face is processed using the resist-ashing method. Thereby, if few, two storage elements which set the predetermined gap and which are the 1st will be formed. Next, after an insulator layer is formed in a substrate and the 1st storage element front face, the 2nd polish recon layer is formed in the at least 1 side of the 1st storage element, and the 2nd storage element is constituted. Subsequently, after an insulator layer is formed in the front face of the 2nd polish recon layer at least, the 3rd polish recon layer is formed between the two 2nd polish recon layers which set the predetermined gap at least, and the 3rd storage element is constituted.

[0017] Moreover, according to this invention, the 3rd polish recon layer is formed on the 1st and 2nd polish recon layers at a substrate and a list. At this time, a slot is made in the 3rd polish recon layer formed between the 2nd polish recon layers. Mask material is embedded in self align in the slot made after this 3rd polish recon stratification, and it is processed on it so that the 3rd polish recon layer may be located between the two 2nd polish recon layers by making this into a mask.

[0018]

[Example] Drawing 1 is the cross section showing one example of the NAND mold semiconductor nonvolatile storage concerning this invention. drawing 1 -- setting -- Tr1 -- the 1st transistor and Tr2 -- the 2nd transistor and Tr3 -- the 3rd transistor and 1 -- in the 1st polish recon layer and 4, the 2nd polish recon layer and 5 show six, and, as for a semiconductor substrate and 2, the 3rd polish recon layer and 7 show [a gate insulator layer and 3] the interlayer insulation film, respectively.

[0019] The 1st transistor Tr1 is the so-called MONOS mold transistor from which the gate was constituted by the 1st polish recon layer 3. That is, the gate insulator layer of an MOS transistor is SiO₂ / SiN/SiO₂, as shown in drawing 2 . It is the memory transistor constituted by the ONO insulator layer which consists of three layers.

[0020] The 2nd transistor Tr2 is a MONOS mold transistor from which the gate was constituted by the 2nd polish recon layer 4. The 2nd polish recon layer 4 which constitutes the gate is formed in the both sides of the 1st polish recon layer 3 as the so-called sidewall through the interlayer insulation film 6.

[0021] The 2nd transistor Tr3 is a MONOS mold transistor from which the gate was constituted by the 3rd polish recon layer 5. The 3rd polish recon layer 5 is formed on the interlayer insulation film 7 formed at the list on the 1st polish recon layer 3 and the 2nd polish recon 4 on the gate insulator layer 2 between the 2nd adjoining transistor Tr2.

[0022] Thus, in this example, it is used as a gate insulator layer of the 1st - the 3rd transistor Tr1, Tr2, and Tr3, and the ONO film which has structure as shown in drawing 2 also has a function as an interlayer insulation film between each transistor, while being used for holding a memory function. In this case, although obtained by oxidizing polish recon, since the oxide film on polish recon has the property which becomes thicker than the substrate 1 top which consists of single crystal silicon, the oxide film (referred to also as Bottom Ox) of the lowest layer of ONO is suitable for the object of layer insulation.

[0023] Next, the manufacture method of the semiconductor nonvolatile storage of drawing 1 is explained, referring to drawing 3. In addition, explanation of processes, such as an ion implantation without the direct relation to a configuration, is omitted.

[0024] First, phosphorus is doped, after forming the ONO film used as the gate insulator layer 2 on a substrate 1 and depositing the polish recon Poly in about 250nm thickness with a CVD method, as shown in drawing 3 (a). In addition, the thickness of the gate insulator layer 2 is SiO₂ of the lowest layer of for example, an ONO film. For thickness, the thickness of 2nm and middle SiN is SiO₂ of 4nm and the maximum upper layer. Thickness is set as 3nm.

[0025] Next, as shown in drawing 3 (b), patterning of the line/the space of the minimum design rule (last shipment) is carried out by Resist PR by the technique of lithography. A pattern gap is set as about 0.4 micrometers.

[0026] Next, as shown in drawing 3 (c), using the resist-ashing method, Resist PR is etched isotropic in the oxygen plasma, and resist line breadth is dwindled to about 0.2 micrometers. Under the present circumstances, it takes into consideration and the gate length of the 1st - the 3rd transistor Tr1, Tr2, and Tr3 determines that the amount to dwindle will become the same eventually. Thereby, the distance between adjoining resist patterns is set to about 0.6 micrometers. As concrete conditions for the resist-ashing method, it is set as power 100W, pressure 200mTorr, and oxygen gas 20SCCM.

[0027] Subsequently, a resist is exfoliated after RIE removes polish recon and an ONO film, as shown in drawing 3 (d). Next, as shown in drawing 3 (e), an ONO film is formed on a substrate 1 and a pattern. At this time, the ONO film on a substrate 1 is formed so that it may become the same thickness as the ONO film of the 1st transistor Tr1, but as mentioned above, the ONO film of the side of the 1st transistor Tr1 and the upper surface becomes thicker than a substrate 1 top. This is because a bottom product (Bottom) Ox becomes thick on polish recon, as mentioned above.

[0028] Next, as shown in drawing 4 (f), after forming the 2nd polish recon layer 4 with a CVD method and doping phosphorus, etchback is carried out by RIE and the sidewall of the 2nd polish recon layer 4 is formed. In this case, the ONO film of the field on the substrate 1 with which the 3rd transistor Tr3 is formed later is removed in the field in which the 1st polish recon layer 3 and the 2nd polish recon layer 4 are not formed. Therefore, most ONO films of the upper surface of the 1st transistor Tr1 are removed.

[0029] Next, as shown in drawing 4 (g), an ONO film is formed on a substrate 1, the 1st polish recon layer 3, and the 2nd polish recon layer 4. It forms so that the ONO film on a substrate 1 may serve as the same thickness as the ONO film of the 1st transistor Tr1 and the 2nd transistor Tr2 at this time, but as mentioned above, the ONO film of the upper surface of the 1st transistor Tr1 and the upper surface of the 2nd transistor Tr2 becomes thicker than a substrate 1 top.

[0030] Next, phosphorus is doped after forming 3rd polish recon layer 3P oly (5) with a CVD method on the whole ONO film, as shown in drawing 4 (h). Next, as shown in drawing 4 (i), patterning is carried out with lithography. The space at this time is good at the minimum interval of a design rule, and does not need to take a doubling gap margin. It is because a sidewall can be substituted for a doubling gap margin. And as shown in drawing 4 (j), the polish recon layer on the transistor Tr2 located in the 1st transistor Tr1 and the 1st about one transistor Tr field by RIE is removed [2nd], and a resist film is exfoliated. Hereafter, it progresses to processes, such as formation of an interlayer insulation film.

[0031] Moreover, the mask material 2, for example, SiO, SOG, or a resist is embedded in self align in the slot made instead of drawing 4 (i) and the process of (j) which were mentioned above when the 3rd polish recon layer 5 was formed by drawing 4 (h), and you may make it process the 3rd polish recon layer 5 on it by making it into a mask.

[0032] Next, it considers how many memory transistors can be formed into the line/space of one unit as a result using drawing 5. In addition, in drawing 4, L shows the minimum design rule, and since it is easy, it makes the line/space the length of 4L/4L. Moreover, the thickness of ONO has ignored.

[0033] As shown in drawing 5 (a), in the case of the usual 1st polish recon, the number of memory transistors is one in a line / space 1 unit. On the other hand, in this example, as shown in drawing 5 (b), four transistors of gate length 2L are formed into 4L+4L=8L. The 1st transistor Tr1 becomes one piece and two 2nd transistor Tr2 GA, and, specifically, the 3rd transistor Tr3 becomes one piece [a total of four]. Consequently, according to this example, a degree of integration can be increased 4 usual times.

[0034] As explained above, according to this example, MONOS is used as an element. After dwindling the gate of the 1st layer by the resist-ashing method and forming an ONO film, Since the transistor by the sidewall was produced by the 2nd polish recon 4 of a two-layer eye, the ONO film was formed further and the transistor was formed between sidewalls in the layer [3rd] 3rd polish recon layer 5 The degree of integration of nonvolatile memory can be improved within the limits of the present processing technology. Consequently, since the cost per bit can be reduced, there is an advantage -- the price of a product can be lowered. Moreover, it can double by the sidewall, a gap margin can be absorbed, and a memory cell can be formed using the minimum processing size.

[0035] In addition, at this example, although the NAND mold semiconductor nonvolatile storage was explained to the

example, it cannot be overemphasized that it is not limited to this and this invention can be applied also to the NOR semiconductor nonvolatile storage of a contact loess mold.

[0036]

[Effect of the Invention] As explained above, according to this invention, the degree of integration of nonvolatile memory can be improved within the limits of the present processing technology. Consequently, since the cost per bit can be reduced, there is an advantage -- the price of a product can be lowered.

[Translation done.]

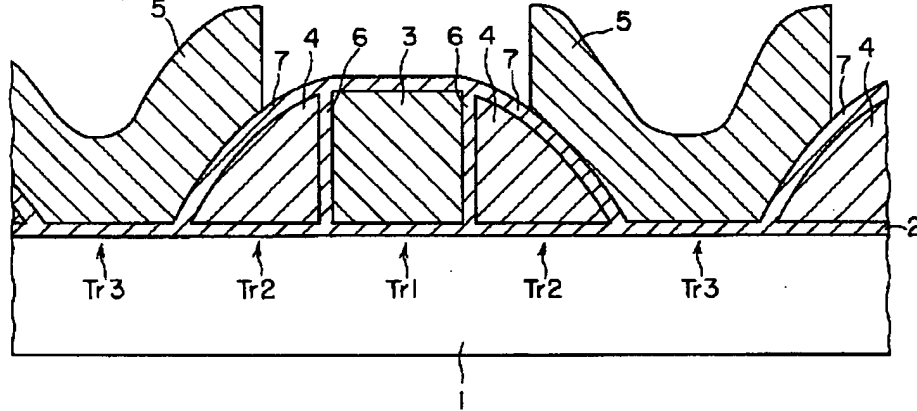
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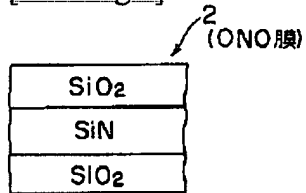
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DRAWINGS

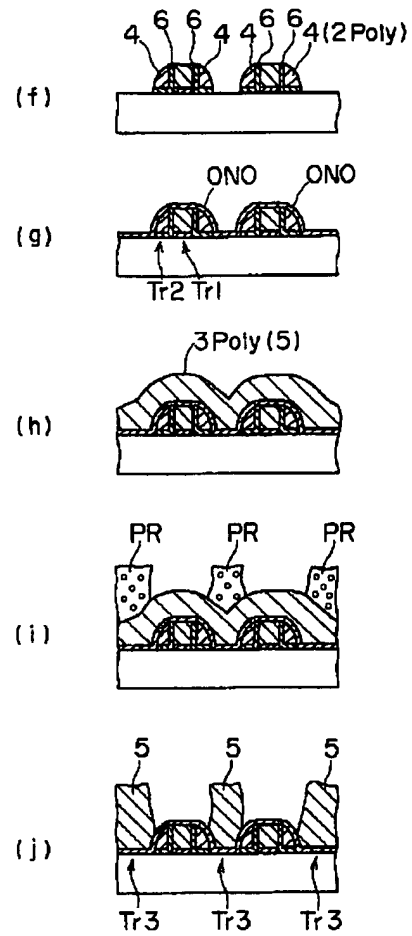
[Drawing 1]



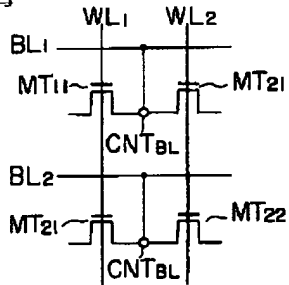
[Drawing 2]



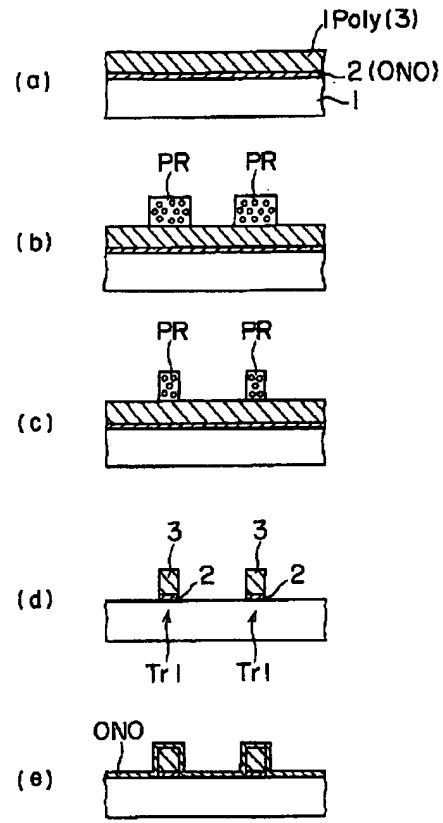
[Drawing 4]



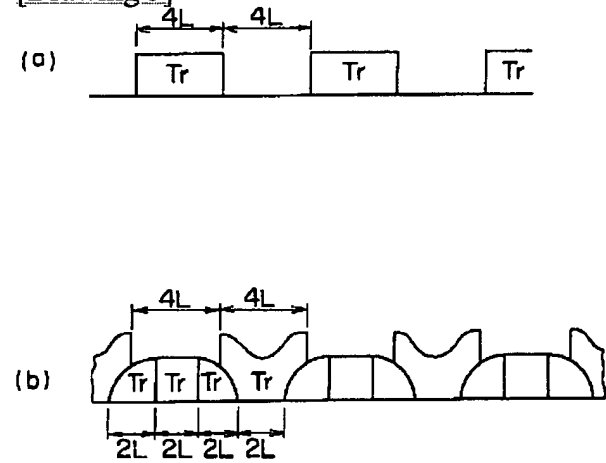
[Drawing 6]



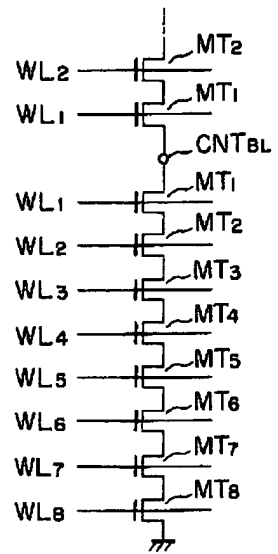
[Drawing 3]



[Drawing 5]



[Drawing 7]



[Translation done.]